

WHAT IS CLAIMED IS:

1 1. An optical amplifier comprising:
2 an optical amplification medium;
3 an excitation source to stimulate the amplification medium to output at least one
4 wavelength gain peak; and
5 a gain equalizer to equalize the output of the amplification medium such that gain is
6 produced at wavelengths other than the wavelength gain peak.

1 2. An optical amplifier according to claim 1, wherein the gain equalizer attenuates
2 gain at the peak wavelength.

1 3. An optical amplifier according to claim 1, wherein the gain equalizer equalizes
2 the output of the amplification medium such that nearly even gain is produced at wavelengths
3 shorter than the wavelength gain peak.

1 4. An optical amplifier according to claim 1, further comprising:
2 a variable attenuator, and
3 automatic level control circuitry to monitor at least one of the input of the optical
4 amplifier and the output of the optical amplifier and maintain the output level of the optical
5 amplifier at a substantially constant level.

1 5. An optical amplifier according to claim 1, wherein the optical amplification
2 medium is segmented and comprises a plurality of amplification medium structures which
3 together produce at least one wavelength gain peak when stimulated by the excitation source.

1 6. An optical amplifier according to claim 5, wherein the amplification medium
2 structures are semiconductor optical amplifiers.

1 7. An optical amplifier according to claim 5, wherein the gain equalizer comprises
2 a plurality of gain equalizer segments, which together produce gain at wavelengths other than
3 the wavelength gain peak.

1 8. An optical amplifier according to claim 7, wherein the gain equalizer segments
2 are positioned with amplification medium structures positioned therebetween.

1 9. An optical amplifier according to claim 7 wherein
2 the excitation source stimulates the amplification medium with pumping light having a
3 pumping wavelength, and
4 the gain equalizer segments are substantially transparent to the pumping wavelength.

1 10. An optical amplifier according to claim 1, wherein the optical amplification

2 medium is doped with at least one rare earth element.

1 11. An optical amplifier according to claim 10, wherein
2 the excitation light source stimulates the optical amplification medium to achieve a
3 population inversion ratio having a positive throughout an optical gain signal wavelength band,
4 the wavelength gain peak is outside of the optical signal wavelength band, and
5 the gain equalizer attenuates the wavelength gain peak.

1 12. An optical amplifier according to claim 1, wherein the optical amplification
2 medium has an input and an output, the optical amplifier further comprising a feedback loop to
3 the excitation source, to monitor the input and the output of the amplification medium and
4 maintain a substantially constant gain within the amplification medium over time.

1 13. An optical amplifier according to claim 1, wherein the optical amplification
2 medium has an input and an output, the optical amplifier further comprising:
3 monitors located at the input and output of the amplification medium to provide
4 feedback; and
5 an automatic gain control circuit connected to the monitors to control the excitation
6 source so as to maintain a substantially constant population inversion ratio within the
7 amplification medium over time.

1 14. An optical amplifier according to claim 1, further comprising a resonator, the
2 optical amplification medium being located within the resonator.

1 15. An optical amplifier according to claim 14, wherein
2 the optical amplification medium has an input and an output, and
3 the resonator comprises:
4 a pair of mirrors that reflect a selected wavelength; and
5 optical couplers provided at the input and the output of the amplification
6 medium to divert a portion of the light emitted from the optical amplification medium to the
7 mirrors.

1 16. An optical amplifier according to claim 15, wherein the optical couplers are 9:1
2 couplers.

1 17. An optical amplifier according to claim 15, wherein the mirrors are fiber grating
2 mirrors.

1 18. An optical amplifier according to claim 15, wherein the gain equalizer is
2 substantially transparent to the selected wavelength.

1 19. An optical amplifier according to claim 15, wherein

2 the selected wavelength reflected by the mirrors is within a signal band used for optical
3 signals to be amplified, and
4 no optical signal is transmitted at the selected wavelength.

1 20. An optical amplifier according to claim 1, wherein the excitation source causes
2 excited emission within the amplification medium.

1 21. An optical amplifier according to claim 1, wherein the optical amplification
2 medium comprises:
3 a cladding;
4 a doped core provided interior to the cladding; and
5 gratings provided within the highly doped core.
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1 22. An optical amplifier according to claim 21, wherein the core is highly doped.

1 23. An optical amplifier according to claim 21, wherein the gratings provided within
2 the doped core serve as the gain equalizer.

1 24. An optical amplifier according to claim 21, wherein the gratings are long-period
2 gratings.

1 25. An optical amplifier device, comprising:
2 an amplification medium comprising at least one erbium doped fiber;
3 an excitation light source to produce a population inversion ratio of about 0.7 to about
4 1.0 within the amplification medium; and
5 a gain equalizer to obtain substantially identical wavelength characteristics for a
6 wavelength band of from about 1490 nm to about 1530 nm.

1 26. An optical amplifier device, comprising:
2 an amplification medium comprising at least one erbium doped fiber;
3 an excitation light source to produce a population inversion ratio of about 0.8 to about
4 1.0 within the amplification medium; and
5 a gain equalizer to obtain substantially identical wavelength characteristics for a
6 wavelength band of from about 1450 nm to about 1490 nm.

1 27. An optical amplifier device, comprising:
2 an amplification medium comprising at least one erbium doped fiber;
3 an excitation light source to produce a population inversion ratio of about 0.3 to about
4 1.0 within the amplification medium; and
5 a gain equalizer to obtain substantially identical wavelength characteristics for a
6 wavelength band of from about 1610 nm to about 1650 nm.

1 28. An optical amplification method, comprising:

2 selecting a population inversion ratio to achieve positive gain throughout an optical
3 signal wavelength band;

4 exciting the amplification medium to the selected population inversion ration to produce
5 a wavelength gain peak at a wavelength outside of the optical signal wavelength band;

6 equalizing the gain to achieve substantially uniform gain over the optical signal
7 wavelength band; and

8 attenuating amplification in wavelength bands outside of the optical signal wavelength
9 band.

1 29. An optical amplification method according to claim 28, wherein the optical

2 signal wavelength band is at wavelengths less than the wavelength of the wavelength gain peak

3 for the amplification medium.

1 30. An optical amplifier comprising:

2 a WDM splitter to separate first and second different optical signal wavelength bands;

3 an optical amplification device for the first wavelength optical signal band, comprising:

4 a first amplification medium;

5 an excitation light source to produce a first population inversion ratio within the
6 first amplification medium; and

7 a gain equalizer to obtain substantially uniform gain over the first optical signal

8 wavelength band;

9 an optical amplification device for the second wavelength band, comprising:

10 a second amplification medium; and

11 an excitation light source to produce a second population inversion ratio within
12 the second amplification medium, the first and second population inversion ratios being
13 different; and

14 a WDM coupler to recombine the first and second optical wavelength bands
15 after amplification.

1 31. An optical amplifier according to claim 30, wherein the first population
2 inversion ratio is less than the second population inversion ratio.

1 32. An optical amplifier according to claim 31, wherein
2 the first and second optical amplification mediums each comprise at least one rare earth
3 element doped optical fiber, and
4 the length of the at least one rare earth element doped optical fiber for the first
5 amplification medium is greater than that for the second amplification medium.

1 33. An optical amplifier according to claim 30, wherein
2 the first amplification medium has a wavelength gain peak, and
3 the wavelength gain peak is outside of the first optical signal wavelength band.

- 1 34. An optical amplifier according to claim 30, wherein the WDM splitter separates
2 first, second and third different optical signal wavelength bands; the optical amplifier further
3 comprising an optical amplification device for the third wavelength band.
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